

Claims

1. (Currently Amended) An apparatus, comprising:
a thermally conductive part having a fluid passageway formed therein, the fluid passageway having a fluid entrance and a fluid exit;
turbulence inducing structure disposed along said passageway in a manner selected to achieve, in response to fluid flow through said fluid passageway, a predetermined temperature profile along said passageway in said thermally conductive part adjacent to said fluid passageway;
wherein said structure includes a plurality of portions which each induce turbulence, wherein each said portion is longitudinally spaced along said passageway by a respective longitudinal distance from every other said portion which is adjacent thereto, wherein said fluid passageway includes a first section and a second section which are separate and which each include at least two of said portions, and wherein said longitudinal distances between said portions in said first section are greater than said longitudinal distances between said portions in said second ~~section; and section;~~
wherein the longitudinal distance between the first section and the fluid entrance is less than the longitudinal distance between the second section and the fluid ~~entrance; entrance;~~ and
wherein said part includes a cold plate.

2. (Currently Amended) An apparatus according to Claim 1, wherein said ~~structure~~ portions includes protrusions extending from a surface of said fluid passageway toward a longitudinal, central axis of said fluid passageway.

3. (Withdrawn) An apparatus according to Claim 1, wherein said structure includes first and second protrusions extending inwardly into said passageway from a surface of said passageway, said first protrusion being generally opposite said second protrusion along a perimeter of said passageway in a plane approximately perpendicular to a longitudinal axis of said passageway.

4. (Currently Amended) An apparatus according to Claim 1, wherein said ~~structure~~ portions includes an inwardly projecting annular protrusion formed along a perimeter of said passageway in a plane generally perpendicular to a longitudinal axis of said passageway.

5. (Canceled)

6. (Canceled)

7. (Canceled)

8. (Currently Amended) An apparatus according to ~~Claim 7~~ Claim 1, wherein said cold plate is made of a material which includes aluminum silicon carbide (AlSiC).

9. (Currently Amended) An apparatus according to ~~Claim 7~~ Claim 1, wherein said part includes tubing at least partially embedded within said cold plate, said tubing having a generally oval cross section, and wherein said passageway extends through said tubing.

10. (Previously Presented) An apparatus according to Claim 9, wherein said tubing is made of a material which includes stainless steel.

11. (Withdrawn) An apparatus according to Claim 9, wherein said structure includes crimps formed in said tubing, said crimps extending radially toward a longitudinal, central axis of said passageway.

12. (Withdrawn) An apparatus according to Claim 9, wherein said structure includes dimples formed upon said tubing, said dimples extending toward a longitudinal axis of said passageway.

13. (Original) An apparatus according to Claim 9, further comprising a fluid supply device in fluid communication with said passageway for causing a thermally conductive fluid to flow through said passageway.

14. (Original) An apparatus according to Claim 13, further comprising a plurality of electronic components thermally coupled with said part, said components generating heat which is transferred to said fluid through said part.

15. (Previously Presented) An apparatus according to Claim 14, wherein said part, said structure, and said electronic components are portions of a phased array antenna system.

16. (Previously Presented) An apparatus according to Claim 14, wherein said temperature profile is generally isothermal.

17. (Currently Amended) An apparatus, comprising:
a thermally conductive flat plate having a fluid passageway formed therein, the fluid passageway having a fluid entrance and a fluid exit;
a plurality of turbulence inducing structures disposed along said fluid passageway, wherein locations of said structures are selected to achieve, in response to fluid flow through said fluid passageway, a predetermined temperature profile along said passageway in said plate adjacent to said fluid passageway;
wherein said ~~structure~~ plurality of turbulence inducing structures includes a plurality of portions which each induce turbulence, wherein each said portion is longitudinally spaced along said passageway by a respective longitudinal distance from every other said portion which is adjacent thereto, wherein said fluid passageway includes a first section and a second section which are separate and which each include at least two of said portions, and wherein said longitudinal distances between said portions in said first section are greater than said longitudinal distances between said portions in said second section; and
wherein the longitudinal distance between the first section and the fluid entrance is less than the longitudinal distance between the second section and the fluid entrance.

18. (Previously Presented) An apparatus according to Claim 17, wherein each said structure is longitudinally spaced along said passageway by a respective longitudinal distance from every other said structure which is adjacent thereto, and wherein the lengths of said longitudinal distances vary along said passageway.

19. (Canceled)

20. (Currently Amended) An apparatus according to Claim 17, wherein said ~~structures~~ portions each include an annular protrusion extending into said passageway.

21. (Original) An apparatus according to Claim 17, further comprising a plurality of electronic devices coupled with a first face of said plate.

22. (Previously Presented) A method of maintaining a predetermined temperature profile along material of a thermally conductive part adjacent a fluid passageway formed within said part, the fluid passageway having a fluid entrance and a fluid exit; comprising:
providing turbulence inducing structure within said fluid passageway; and
selecting a configuration of said structure to achieve, in response to fluid flow through said fluid passageway, the predetermined temperature profile along said passageway in said part adjacent to said fluid passageway;
configuring said structure to include a plurality of portions which each induce turbulence, said passageway having first and second sections which are separate and which each include at least two of said portions;
selecting locations of said portions along said passageway such that each said portion is longitudinally spaced by a respective longitudinal distance from every other said portion which is adjacent thereto, wherein said longitudinal distances between said portions in said first section of said passageway are greater than said longitudinal distances between said portions in said second section of said passageway; and
wherein the longitudinal distance between the first section and the fluid entrance is less than the longitudinal distance between the second section and the fluid entrance.

23. (Canceled)

24. (Canceled)

25. (New) An apparatus, comprising:

a thermally conductive part having a fluid passageway formed therein, the fluid passageway having a fluid entrance and a fluid exit;

turbulence inducing structure disposed along said passageway in a manner selected to achieve, in response to fluid flow through said fluid passageway, a predetermined temperature profile along said passageway in said thermally conductive part adjacent to said fluid passageway;

wherein said structure includes a plurality of portions which each induce turbulence, wherein each said portion is longitudinally spaced along said passageway by a respective longitudinal distance from every other said portion which is adjacent thereto, wherein said fluid passageway includes a first section and a second section which are separate and which each include at least two of said portions, and wherein said longitudinal distances between said portions in said first section are greater than said longitudinal distances between said portions in said second section;

wherein the longitudinal distance between the first section and the fluid entrance is less than the longitudinal distance between the second section and the fluid entrance; and

wherein said portions include protrusions extending from a surface of said fluid passageway toward a longitudinal, central axis of said fluid passageway.

26. (New) An apparatus according to Claim 1, wherein said portions include first and second protrusions extending inwardly into said passageway from a surface of said passageway, said first protrusion being generally opposite said second protrusion along a perimeter of said passageway in a plane approximately perpendicular to a longitudinal axis of said passageway.

27. (New) An apparatus according to Claim 9, wherein said portions include crimps formed in said tubing, said crimps extending radially toward a longitudinal, central axis of said passageway.

28. (New) An apparatus according to Claim 9, wherein said portions include dimples formed upon said tubing, said dimples extending toward a longitudinal axis of said passageway.

29 (New) An apparatus, comprising:

a thermally conductive part having a fluid passageway formed therein, the fluid passageway having a fluid entrance and a fluid exit;

turbulence inducing structure disposed along said passageway in a manner selected to achieve, in response to fluid flow through said fluid passageway, a predetermined temperature profile along said passageway in said thermally conductive part adjacent to said fluid passageway;

wherein said structure includes a plurality of portions which each induce turbulence, wherein each said portion is longitudinally spaced along said passageway by a respective longitudinal distance from every other said portion which is adjacent thereto, wherein said fluid passageway includes a first section and a second section which are separate and which each include at least two of said portions, and wherein said longitudinal distances between said portions in said first section are greater than said longitudinal distances between said portions in said second section;

wherein the longitudinal distance between the first section and the fluid entrance is less than the longitudinal distance between the second section and the fluid entrance; and

wherein said portions include an inwardly projecting annular protrusion formed along a perimeter of said passageway in a plane generally perpendicular to a longitudinal axis of said passageway.